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Conformal Array Adaptive Processing

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AIR FORCE RESEARCH LABORATORY
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APPROVED: /s/

BRAHAM HIMED
Program Manager

FOR THE DIRECTOR: /s/

RICHARD G. SHAUGHNESSY
Chief, Rome Operations Office
Sensors Directorate

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6. AUTHOR(S)
Braham Himed

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Lockheed Martin M&DS-RS
P. O. Box 85
Litchfield Park Arizona 85340-0085

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Air Force Research Laboratory/SNRT
26 Electronic Parkway
Rome New York 13441-4514

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AFRL Project Engineer: Braham Himed/SNRT/(315) 330-2551 Braham.Himed@rl.af.mil

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13. ABSTRACT ***(Maximum 200 Words)***
The goals of this effort were to demonstrate the applicability of adaptive differential synthetic aperture radar (ADSAR) techniques to radar data collected from conformal arrays with three or more channels. The ADSAR technique first generates complex images at each channel, using SAR or SAR-like techniques so that the clutter is as nearly identical as possible in each channel. By taking the known (collection) geometry into account, some aspects of the clutter statistics are made nearly stationary over range, Doppler, and spatial channel. This reduces the number of degrees of freedom (DOF) required to cancel the clutter, using traditional Space-Time Adaptive Processing (STAP) techniques. The resulting ADSAR-STAP techniques were to be studied in terms of their performance in the detection and localization of ground moving target indication (GMTI). This effort was terminated at the convenience of the government for lack of technical progress.

14. SUBJECT TERMS
Conformal Arrays, STAP, SAR, ADSAR, GMTI, Eigencanceler

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Abstract

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Keywords: Conformal Arrays, STAP, SAR, ADSAR, GMTI, Eigencanceler

Introduction

It is well known that equipping airborne systems with high performance antennas for radar is often difficult without compromising performance in other areas such as aerodynamics and signature suppression. The use of conformal arrays is growing because of design conflicts. However, many simplifying assumptions made by conventional adaptive processing approaches, including uniform linear/planar arrays and stationary data, will be violated by conformal aperture designs. Moreover, the extent to which conformal arrays will support accurately placed adaptive nulls with adequate null depth to achieve clutter cancellation requirements must be ascertained. To accomplish this goal, Lockheed Martin proposed to use all available knowledge of system errors and then create the most benign environment possible for the adaptive portion of the processing. In this manner, they would take extreme care to make adaptive processing robust by using knowledge of signal characteristics.

In this effort, a suite of adaptive algorithms for multi-mode, multi-channel radar utilizing conformal arrays, was to be developed. The algorithms would have been evaluated for their ability to support multiple (and possibly simultaneous) modes of radar operation such as Fixed Target Imaging (FTI), Ground Moving Target Indication (GMTI), Airborne

Moving Target Indication (AMTI), Electronic Counter-Countermeasures (ECCM). They would also have been evaluated in terms of their detection performance and parameter estimation performance, including range, speed, heading, and azimuth. Methods for maintaining SAR and GMTI performance in a hostile future environment would also been demonstrated

Program Methodology

This program was a twenty-four month study program with specific tasks focused on the goal of developing, testing, and arriving at initial performance predictions. The program contained the following tasks:

(1) **Algorithm Development**: This task would have developed and implemented the ADSAR – STAP concept and location algorithms required for an MTI/SAR radar utilizing a conformal array and developed the necessary analysis software required to make performance predictions.

(2) **Performance Estimates**: Radar performance predictions would have been developed for probability of detection (P_d), probability of false alarm (P_{fa}), and parameter estimation accuracy for a selected set of conformal collection geometries using both airborne and space-based assets. Initially the algorithms would have been tested with simulated data using MATLAB and RLSTAP.

(3) **Data Source Identification and Performance Comparison**: M&DS - ISRS would have identified possible sources of multi-channel conformal array data. This may have been existing data or may have been collected using the M&DS - ISRS Tuxedo collection platform. The performance of the algorithms would then have been determined using the collected data and compared against simulation results.

(4) **TIM Attendance and Presentation:** The contractor would have conducted presentations/meetings at times and places specified in the contract schedule. These included four Technical Interchange Meetings (TIM) to report on the technical progress and program scheduling and funding. The location of these meetings would have alternated between AFRL, Rome Research Site, Rome, NY and LM M&DS – ISRS in Goodyear AZ.

Technical Issues

This effort started in September 2003. After the kickoff meeting, which took place in Goodyear, AZ, Lockheed Martin showed displayed an excellent strategy and team capable of reaching the goals and objectives set forth in the statement of Work. Unfortunately, few weeks later, the principal investigator (PI) on this effort, Dr. Howard Mendelson left Lockheed Martin for SAIC. AFRL received assurances from Lockheed martin that the program will go on as scheduled, and that they would do their best to fill the PI position as soon as possible.

However, as time went by, it became apparent that that Lockheed Martin did not a have a strong and knowledgeable PI to carry out the proposed work. AFRL learned that they did not even have a data simulator. They even admitted for the first time that their strongest asset was their data analysis capability. They expected AFRL to provide them with data for them to process, which defeats the purpose of the effort itself. AFRL personnel visited Lockheed Martin another time to try to work with their personnel and find a way out of this situation. At that meeting, Lockheed Martin suggested hiring Mission Research Corporation (MRC), as their sub-contractor in this effort. MRC had the missing expertise in adaptive signal processing. This seemed to be reasonable way out, given the situation.

Unfortunately, as time went by, it became also apparent that the Lockheed Martin-MRC team was not going to deliver on the set objectives for this program. AFRL personnel visited Lockheed Martin one more time and it was definitely clear that the program was not going anywhere.

After further consultations with management, AFRL/SNRT decided to terminate this contract for lack of technical progress.